ABSTRACT

In 2020, manufacturing of the 1st sector of the ITER Vacuum Vessel has been completed since manufacturing start in Feb 2012. Each step of the manufacturing was challenge as a First-of-a-Kind (FOAK) and a French Nuclear Pressure Vessel. The paper provides an overview of the major technical challenges which were overcome during the 1st ITER VV sector manufacturing and lessons learned over the last 10 years.

CHALLENGES

ITER Vacuum Vessel (VV) sector and Requirements

MANUFACTURING CHALLENGES AND OVERCOMING

- **Nuclear Safety Process**
  - Required a great deal of time & effort to proceed manufacturing by a long documents review & approval process, and the complicated work interface → A necessity arose for process simplification!!
  - VV Project Team (VVPT) created in 2015 for simplified & effective project management as one team spirit (IO-CT + IO-DAs)
  - Whole process greatly simplified by implementation of the VVPT

- **Tight manufacturing tolerances**
  - Narrow gap gas tungsten arc welding as a basic welding process (+electron beam welding) to minimize welding distortion
  - Developed fabrication sequence based on the results of welding distortion analysis and full scale mock-ups manufacturing
  - Dedicated jigs from each segment manufacturing stage to minimize welding deformation
  - Virtual fitting in advance using 1) as-built dimensional inspection data of each segment, 2) required weld root matching tolerance for gap & misalignment, 3) welding distortion analysis results for the final assembly according to HHI’s welding sequence

- **100% inspection requirement by ESPN order**
  - 15 times of Phased Array UT qualifications completed (with 157 qualification blocks and 141 documents) under VVPT & ANB witness
  - To achieve 100% volumetric examination requirement, all special cases technically verified and qualified successfully
  - 100% visual inspection on backside welds by ESPN Order is another technical challenge because direct visual inspection is not possible
  - Dedicated guiding tool system developed based on precise endoscope system and successfully qualified

LES SONS LEARNED

- Expected significant manufacturing schedule reduction for the remaining KO sectors by 1) improved document management system and the updated quality control to prevent similar non-conformities, 2) several technical improvements.

- It’s clearly recognized that the importance of the regulation and code for manufacturing of the ITER VV sector. The appropriate regulation and code need to be developed for VV of a future fusion power plant which well balanced between economic and safety point of view.

ACKNOWLEDGEMENTS / DISCLAIMER

- This work was supported by the National R&D Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science & ICT (No. 2007-2006979, Development and Procurement of ITER Vacuum Vessel)
- The views and opinions expressed herein do not necessarily reflect those of the ITER Organization